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ABSTRACT

Research determined the effectiveness of automobile simulators in fostering the safe operation of automobiles. A 20-hour driver improvement course was administered to 238 licensed drivers at Fort Lewis, Washington. Approximately half of the trainees received a program taught entirely by conventional methods, while the other half received a program of similar content but including eight hours of simulator instruction. Results of specially constructed tests indicated that simulators were superior to conventional media for developing good driving habits but were no more effective in teaching driving knowledges or influencing driver attitudes. It was concluded that, while simulation represents a potentially valuable means of improving driver habits and skills, substantial modification of current simulator equipment and film is needed to attain this potential. (Author)

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An Experimental Evaluation of a Driver Simulator for Safety Training

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by

A. James McKnight and Harold G. Hunter

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HumRRO Division No. 1 (System Operations)
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The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
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Technical Report 66-9
Exploratory Study 20

The Human Resources Research Office is a nongovernmental agency of The George Washington University, operating under contract with the Department of the Army (DA 44-188-ARO-2). HumRRO's mission is to conduct research in the fields of training, motivation, and leadership.

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FOREWORD

This report describes an empirical evaluation of the effectiveness of automobile simulators in teaching safe vehicle operation to qualified military drivers. The research was conducted by the Human Resources Research Office under Exploratory Study 20, Driver Training, by HumRRO Division No. 1 (System Operations) at Alexandria, Virginia. Dr. J. Daniel Lyons was Director of Research.

The request for research was made by HQ, U.S. Continental Army Command, and the U.S. Army Transportation School, Fort Eustis, Virginia. The study was conducted at Fort Lewis, Washington, in the fall of 1964. Results were communicated to the Transportation School in December 1964.

Members of the research team were Dr. A. James McKnight, Study Leader, Dr. Harold G. Hunter, and Dr. Richard D. Behringer. The following individuals also assisted in administration of the experiment: Mr. Warren D. Barr, U.S. Army Transportation School; Lt. Col. Erwin H. Hayes, Commandant, Capt. Marvin K. Ketterer, Sgt. John B. Sheppard, and Pfc. Douglas T. Silver, Fort Lewis School Center, Fort Lewis, Washington.

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Meredith P. Crawford
Director
Human Resources Research Office

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SUMMARY AND CONCLUSIONS

Purpose of the Study

An evaluation of the effectiveness of simulators used by the Army to improve driver safety was undertaken by the Human Resources Research Office at the request of Headquarters, U.S. Continental Army Command, and the U.S. Army Transportation School, Fort Eustis, Virginia. While the value of driver simulators in the teaching of basic vehicle operation has been established, there is no reliable evidence as to their effectiveness, relative to conventional media, for improvement of driver safety. The evaluation consisted of an experimental comparison of simulation and conventional media in a military driver improvement program.

The kind of simulator used in the study—the motion picture type—has certain basic limitations which preclude training in (a) continuous control skills that require a display-control interaction, and (b) procedures that do not involve vehicle controls (such as hand signals). However, preliminary analysis of the simulator equipment and film indicated potential usefulness for improving driving knowledges, attitudes, and habits.

Method

The experimental comparison was conducted at Fort Lewis, Washington, from August through October 1964. A 20-hour driver safety education course was administered to 238 licensed drivers, approximately half receiving a program utilizing the simulator, and half, a program using only conventional media. The two groups, essentially equivalent with respect to critical pre-training variables, were tested following the completion of the courses on a written knowledge test, an opinion survey, a simulator test of driving habits, and a trainee report of driving behavior.

Results

The results indicated:

(1) No significant differences in knowledge between the simulator and conventional groups.

(2) Significantly better performance by the simulator group on tests of those driving habits that were most heavily emphasized in the simulator programs.

(3) No significant differences for the remaining driving habits, for trainee opinions, or for reports of driving behavior.

Conclusions

(1) The simulator studied is superior to conventional media in fostering safe driving habits when such habits are the object of heavy emphasis in simulator programs. It is not superior in communicating driving knowledges or molding driver opinions with respect to safety.

(2) Simulators represent a promising approach to the development of safe driving habits and skills. It appears, however, that realization of the simulator's full potential will require substantial modification of simulator film content, equipment, and schedule of presentation.

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DEFINITION OF THE PROBLEM

In the search for means of improving the performance of automobile drivers, increased emphasis has been given to the use of simulation techniques. A variety of devices have been designed to simulate certain portions of the driver's tasks. While designed largely to teach beginning drivers the basic elements of vehicle operation, these devices often place considerable emphasis upon driving safety. As a result their use has been extended to the improvement of experienced drivers.

Driver Simulators

Types of Simulators

Existing automobile simulators have been described by Hulbert and Wojcik (1). Those intended largely for training applications fall into the following categories:

(1) Point Light Source. The image of a landscape is created upon a screen by projecting light from a small source through a transparency with objects either placed, painted, or photographed on it. The transparency moves in response to the operator's controls so that an illusion of driving through the landscape is created.

(2) Model Vehicles. The display is a model vehicle which either moves along a stationary roadway or is positioned above a moving belt representing the road. Speed and/or direction are under the operator's control.

(3) Motion Picture. The driver operates his simulated vehicle in response to a wide-screen color motion picture of driving scenes as viewed through the windshield. His manipulation of the wheel, brake, accelerator, clutch, horn, and turn indicators are scored for their adequacy.

Highly sophisticated devices employing remote control TV and direct optical viewing are under development but are likely to prove too costly for application to mass individual training in the immediate future.

Each approach to simulation has its assets and liabilities. In the point light source and model vehicle approaches, movement of the simulated vehicle is under the control of the operator, making these methods seemingly more suitable to teaching actual control skills. A motion picture display, on the other hand, is already "programed" on film and cannot be responsive to the operator. However, the fact that the film display is independent of individual trainee control allows a single display to be used simultaneously by an entire class. Moreover, the high resolution of the motion picture image can accommodate the complex driving situations that are frequently involved in teaching the fine points of safe vehicle operation. Motion picture simulators have proven to be the most popular type of device for driver training.

Effectiveness of Simulation

Studies of simulator effectiveness have been focused largely upon the simulator's role in teaching the beginning driver. Used in high schools,

simulators have reduced the expense of behind-the-wheel instruction. When the role of simulation in improving safety of operation by licensed drivers is considered, their value is less clear.

Scherer (2) compared simulator training with a standard lecture-film approach and with a test program in which the trainees' psychological and physical deficiencies were discussed with them. The "psycho-physical" test program proved superior in terms of gains on knowledge and attitude measures. The simulator and lecture-film approaches were second best on the attitude and knowledge measures, respectively. However, the wide differences in training content among the three groups preclude any conclusions about the merits of the training techniques themselves.

Studies concerning the influence of simulation upon individual driving records are similarly equivocal. The 25th Air Division of the U.S. Air Force noted a reduction in accident rate following the introduction of simulators at three installations (3). However, the simulators were part of a broad driver safety program instituted at the same time. Moreover, the overall Air Force accident rate showed a decline for the same period. Just what the simulators contributed to the observed accident reduction cannot be detected.

McAmis found an improvement in high-accident bus drivers following remedial instruction with a simulator (4). However, the number of cases was small, no tests of statistical significance were performed, and there was no control for statistical regression (i.e., the statistical tendency for an extreme group to be closer to average in subsequent observations).

The Military Problem

In the spring of 1964, Headquarters, U.S. Continental Army Command (USCONARC), and the U.S. Army Transportation School requested that HumRRO evaluate the effectiveness of driver trainer simulators of the type currently in use by the Army. The function for which simulation was to be evaluated was that of improving driver safety, as distinguished from beginning instruction or training for transfer from civilian to military vehicles.

At the time of this request, a total of 48 simulators existed at the following three Sixth Army locations: Fort Ord, California, 16; Fort Lewis, Washington, 24; and Presidio of San Francisco, 8;. After the study began, 12 simulators were installed at Fort Huachuca, Arizona.

In order to determine the effectiveness of simulation as a medium of safety instruction, an experimental comparison of simulator versus conventional training was performed at Fort Lewis, Washington, from August to October of 1964.

Analysis of the Simulator Potential

The first step of the experiment was to identify the potentialities of the simulator. The equipment and available film programs were examined.

Equipment

The simulator studied utilizes a 16mm cinemascope lens to project a wide-angle color motion picture upon a screen in front of the class. The scene is primarily that which would be viewed from the driver's seat of an automobile. The view encompasses what the rear view and side view mirrors would show. When the situation calls for the driver to look behind him (e.g., backing), the scene shifts to a rear view which the driver observes in mirrors mounted behind

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him on either side. At intersections the camera frequently pans right and left, simulating the views of the crossroad to a driver looking in both directions.

In addition to a view outside the car, critical dash displays are provided in the simulator. A speedometer registers simulated speed in response to accelerator control, a signal light comes on when the turn indicator is activated, and a generator warning light indicates when the "motor" is not running.

The Fort Lewis simulator classroom is shown in Figure 1. Students are shown seated in the driver simulators.

Fort Lewis Simulator Classroom

A photograph of students receiving simulator instruction at Fort Lewis, Washington.

Figure 1

The simulators are equipped with the following standard controls: wheel, gear shift, foot brake, parking brake, accelerator, clutch, horn, and turn indicator. The driver's responses to these controls are printed on a permanent record which the instructor interprets after the film is completed.

In a classroom the student is able to observe the responses of his fellow students. The assistance he receives in this manner thwarts to some extent detection of his driving deficiencies under simulator conditions.

Subject Matter Covered by Films

The simulator studied was developed largely for beginning driver instruction and does not offer a film program aimed specifically at driver improvement. About half of the films, slightly over two hours' showing time, consists of material appropriate to the qualified driver. This includes films on city traffic, highway and expressway driving, passing, and emergencies, and a review film. While some footage of the remaining films is relevant, it is so interspersed with elementary material as to be of little use in a program for licensed drivers.

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The appropriate film content will be discussed in terms of its relation to driver knowledges, skills, attitudes, and habits.

Knowledges. A primary function of the simulator is to develop knowledge of safe driving procedures. To determine how much coverage was given to safe driving procedures in current films, a survey was made of existing driving literature including texts, pamphlets, and periodicals. All driving procedures concerned specifically with driving safety were recorded. A total of 164 procedures, including situations and the appropriate responses (e.g., "when stopped at an intersection, maintain brake pressure"), was obtained.

So far as simple coverage of the items included in the survey is concerned, the films appeared to be quite comprehensive, roughly 70% of the items being mentioned at one time or another. Adverse weather conditions, night driving, skids, and a variety of small items are omitted. Some of these are to be included in films currently being planned.

However, the chief value of simulation is not simply dissemination of information, but the ability to present situations calling for the application of driving knowledges, and to correct the student when he fails to make an appropriate response. For example, the driver can be warned against turning his wheels to the left while waiting to make a left turn in order to avoid being pushed into the oncoming stream of traffic if struck from behind.

To exploit its maximum pedagogical value, full use must be made of the response-evoking capacity of the simulator. Approximately a quarter of the procedures in the survey of driving literature are made the objects of response checks. The remaining three-quarters cannot be checked directly because of limitations inherent in programed simulators.

One group of omitted procedures consists of those situations which cannot readily be depicted by a two-dimensional display, (e.g., correct passing distance). Another consists of motor responses such as hand signals, wheel grip, and mirror checks which cannot be registered by the recording equipment.

There also exists a host of perceptual "look out for" responses which cannot be directly checked; however, certain of these can be checked indirectly by determining whether the appropriate motor precautionary response occurs when a potential hazard exists. For example, the simulator driver should slow down when passing a playground. Where the situation does not call for an immediate response, an emergency may be precipitated, the assumption being that those who have perceived a potential danger will respond quickly when an emergency arises. In the playground example, the driver who is already driving slowly can be checked for his attentiveness by observing his response to a child's darting suddenly into his path. Indirect checks of perceptual responses add approximately 10% to the proportion of items in the survey which are checked in some way.

The final group of safe driving procedures that are omitted involves those which call for a dynamic display-response interaction; that is, situations in which the driving scene must change in response to the student's actions as well as vice versa. This category includes continuous control tasks such as maintaining proper following distance, turning, using correct lanes, passing, and blending with traffic. As noted earlier, this aspect of driving is not within the capability of a programed film display.

Skills. The trainee may know what to do and yet lack the requisite "skill." Unfortunately, the teaching of perceptual skills such as judgment of passing distance, and control skills such as escaping from a skid, are hampered by the simulator's display limitations and the lack of a control-display interaction.

One aspect of driving skill which does appear amenable to simulation is the ability to cope with sudden emergencies. Granting that emergencies frequently demand certain control skills which cannot be accommodated by the simulator, they also require certain discrete responses which the simulator can readily check, (e.g., pumping the brake and selecting the best escape route). The ability to execute these responses very rapidly in the face of an emergency can be considered an important safe driving skill. By simulation, the trainee can be given repeated practice in dealing with various types of emergencies until the appropriate reaction becomes a matter of reflex—something that cannot be accomplished with an automobile.

While a great number of emergencies arise throughout the course of each simulator program—indeed, driving becomes one crisis after another—a large proportion of these episodes involve a "natural" (i.e., previously learned) response such as "hitting the brake" or steering away from trouble. The purpose of presenting emergencies in these films seems to be to improve habits and attitudes rather than to develop a skilled reaction. Those situations—such as impending collision, blowouts, and brake failures—which demand learning a new, fairly sophisticated response, do not receive extensive treatment. The use of "emergency procedures" simulators elsewhere (e.g., pilot ejection trainers) indicates the importance of repeated practice in attaining rapid responses.

Attitudes. Many instructors feel that the greatest contribution of driver simulators in actual practice has been their effect upon attitudes. Part of this effect is upon driver training in contrast to driving. The course itself is fun with the little cars. However, instructors feel that exposure to simulated emergencies and the driving foibles of others (e.g., sudden turns and stops) develops a greater respect for the rigors of the road and encourages a defensive attitude.

Habits. A major segment of the simulator program is not concerned so much with teaching driving procedures as it is with establishing those already known at the level of a driving habit. Through simulation, procedures may be subject to relentless practice so that the driver will perform them without having to think about them, thus assuring a high probability of occurrence when required. Naturally, the responses must be called for frequently in actual driving in order for them to be maintained once they have been established in training.

Simulator films showed an intent to establish certain driving habits insofar as the equipment permits. For example, the use of turn indicators was checked 46 times. Judging from available trainee performance records, considerable success had been realized in the elimination of signaling errors by the conclusion of the filmed program. On the other hand, "covering" the brake in order to signal stops to those behind, and maintaining brake pressure while stopped, were not frequently repeated.

Objective of the Research Experiment

The simulator under study appeared to have some potential for dealing with a limited number of driving knowledges and habits, specifically those which (a) involve simple visual cues, (b) require responses which directly or indirectly involve vehicle controls, and (c) do not demand display control interactions. In addition, the ability of the simulator to secure some degree of involvement in simulated hazards offers a potential impact upon driver attitudes. While film simulators have a potential for teaching emergency skills, this feature does not appear to have been truly utilized in the simulator film program under study.

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The objective of the experimental problem of the study became that of determining whether or not the simulator was superior to conventional Army instructional media in developing safe driving knowledges, habits, and attitudes.

METHOD

To determine the effectiveness of driver simulators, an experimental comparison of training with simulators and training with conventional training media was performed at Fort Lewis, Washington. This section describes the training programs, criterion measures, and administration of the experimental comparison.

Training Programs

The 36-hour Fort Lewis Driver Safety Education course served as the basis for the experimental training program. This course was abbreviated to 20 hours or two and one-half days in order to (a) permit two classes to be run each week, (b) render course length more representative of Army driver safety training, and (c) maintain a relatively high proportion of simulator time in the simulator course.

During 8 ½ hours of the 20-hour course, the experimental group was trained on the simulators and the conventionally trained group received standard instruction. Both groups received a common segment of 7 hours of non-simulator instruction on such subjects as driver psychology, law enforcement, and car maintenance. Both programs also contained 4 ½ hours of non-academic activities such as processing and examinations. The two training programs are summarized in Appendix B.

The simulator group was administered the eight simulator films considered appropriate for qualified drivers. One hour was devoted to each film and included (a) a brief preview of essential points in the film, (b) operation of the simulator in response to the film, and (c) a critique of individual student performance. The eight hours of simulator instruction were alternated with the common subjects for the simulator-trained group.

The lesson plans prepared for the conventional training course included each item of information contained in the simulator film program. Discussion of traffic situations displayed by means of transparencies and a magnetic traffic board provided a degree of active student participation in conventional classes. Almost three hours of training film dealing with roughly the same content areas as the simulator films were shown to the students in the conventional training group.[1] The conventional course, established for the experiment, lacked the polish of the simulator course, which had been taught for a full year.

Criterion Measures

Practical considerations in regard to the size of the samples and the time available governed the criterion approach. Driving records provide the only direct index of long-term driving behavior. However, estimates of trainee accident and violation rates indicated that—even were simulators to produce as much as a 20% reduction—well over a thousand individuals and an 18-month follow-up study would be needed to obtain reliable results. A smaller difference

[1]These films were obtained from various sources, with the assistance of the Fort Lewis Safety Director's Office.

in results would require an even greater number of trainees to establish a statistically significant result.

Therefore, specially prepared measures of driving knowledges, attitudes, and habits were used to evaluate the results of simulator and conventional training. If results obtained from these measures were highly favorable to simulation, then a full-scale study of simulator effectiveness using long-term driving records would be warranted.

Descriptions of the criterion measures are presented below; examples of each measure are provided in Appendix A.

Knowledge Test

A 50-item information test was developed from an original pool of over 200 items dealing with course material. Thirty of the 50 items in the knowledge test covered information not presented by the simulator films. The evaluation of simulator effectiveness was to include, in addition to those knowledges which are taught directly, the potential effectiveness of simulation upon the student's motivation toward the entire course. If simulators possess some general incentive value, their influence should be evident throughout the training program.

Opinion Survey

The assessment of attitudes toward safety is complicated by the tendency of people to wish to appear to be safe drivers. In addition, available driver "attitude" tests are heavily loaded with items which reflect basic personality tendencies and hence are not likely to indicate any change due to relatively limited training.

An opinion survey was prepared as an indirect means of assessing underlying attitudes toward safe driving. A questionnaire was prepared dealing with 16 issues covered in the course, including such items as proper following distance, night driving, driver education, and the value of the Fort Lewis course.

For each issue a set of four alternative opinion statements was prepared. Opinions were either of evaluative nature or in the form of "facts." Each opinion reflected a somewhat different degree of concern for safety. The trainee was to select the statement with which he was in the greatest agreement. In the example following, the first opinion, that you "should never drive" when you have had something to drink, suggests a somewhat greater concern for safety than to "try to avoid driving."

Drinking and driving:

(1) You should never drive if you have had anything at all to drink.
(2) You should try to avoid driving if you have had something to drink.
(3) A small amount of alcohol won't prevent you from driving safely.
(4) Some people can drink quite a lot and still drive safely.

The attempt was made to make all opinions appear reasonable; indeed, there was no "correct" answer.

Driving Habits

Driving habits posed the most formidable of the criterion measurement problems owing to the lack of a mechanism for recording behavior under normal driving conditions, since drivers would be on their "best behavior" when they are being observed. However, if the period of observation were sufficiently long, enough lapses might occur to show the relative strength of habits for different individuals or groups of individuals being compared. The simulator

offered the only means of providing a lengthy, standardized driving session to measure actual driving behavior. This procedure, however, gave the simulator-trained group an advantage as this group was more familiar with the controls and the scoring system.

Two test reels were assembled from footage not included in the simulator program.[1] Situations called for (a) use of turn signals, (b) maintenance of proper speed, (c) precautionary responses to apparent hazards, (d) use of the brake when stopped, and (e) attention to signs of potential emergencies (as measured by responsiveness to emergencies when they occur).

In administering the test films, the following procedures were adopted:

(1) The simulator orientation period from the simulator training program was administered to conventional graduates prior to the start of the test.

(2) Necessary road directions were given orally by the administrator since the original sound track contained unwanted information and was turned off.

(3) Long, uninterrupted sequences were used to help maintain a normal driving illusion; necessary transitions were made as smooth and unnoticeable as possible.

(4) Emergency situations used to test perceptual knowledges and habits were held for the second film in order to minimize interference with the "normal" driving illusion.

Behavior Report

While simulator performance was the primary measure of driving habits, it seemed desirable to collect the trainee's report of any improvement in his driving habits since completion of the course. While probably somewhat exaggerated, these reports were believed to provide a useful index of relative improvement for comparison of the two training programs. Statements concerning driving behavior since completion of training were prepared, for example, "I signal more turns than I used to." The individual was asked to indicate whether or not each statement was true of his own behavior.

Administration of Training Equipment

Subjects

The conventional and simulator courses were administered to 12 successive Fort Lewis Driver Safety Education classes from 17 August to 16 October 1964. Half became simulator and half, conventional classes. A counterbalanced order (S-C-C-S-S- . . . C) was used to control for systematic time-related effects.

Each unit stationed at Fort Lewis is levied a weekly quota of personnel to be assigned to the course. Individual assignments are made by unit commanders. While this system could not be altered for purposes of experimental control, there was little likelihood that selections were biased in favor of either simulator or conventional classes, since commanders had no reason to favor one method over the other.

Efforts were made to keep each adjacent pair of simulator and conventional classes approximately the same size, since any marked difference in

[1]These test reels utilized simulator film made available for this study by Dr. Slade Hulbert, Institute of Transportation and Traffic Engineering, UCLA, and Dr. Marshall Crawshaw.

class size could confound the comparison of training media. Analysis of Fort Lewis Driver Safety Education classes over the previous year disclosed a significant tendency for smaller classes to perform better on written tests ($r = .44$). This is similar to findings elsewhere that smaller simulator classes performed better on road tests (5).

Training Administration

The "common" material was taught under conditions as nearly identical as possible for the two groups, including having the same instructors teach both groups. No mention of the simulators was made to the trainees in the conventional program in order to avoid any feeling on their part that they were being deprived of something special. Those students who inquired about the simulators were told that the course was under study by Fort Lewis and were led to believe that no simulator instruction was currently being given. Because of the course's brevity no students dropped or were dropped for any reason; all who started, finished.

Upon reporting for training, each student was administered a pre-training booklet consisting of the following:

(1) Personal Information Questionnaire: Identifying information including Army serial number, parent unit, and civilian driver's license number.

(2) Driving Experience Questionnaire: Driving history including years of driving experience, previous driving instruction, and recent accident and violation data.

(3) Knowledge Test: Twenty-four items selected from the same pretested 200-item pool as the criterion test; 11 of these items also appeared in the criterion test.

(4) Opinion Survey: The 16-item opinion survey.

The primary purpose of these measures was to establish the pre-training equivalence of the conventional and simulator groups with respect to vital statistics, experience, knowledge, and attitude. Such condition was necessary in order to assure that subsequent differences could be clearly attributed to type of training. The test film was not used as a pre-training measure because early exposure might have jeopardized the validity of that film for later, post-training use.

Testing

Effects of driver training must be of a lasting nature if they are to influence long-term driving behavior. To permit some measure of retention, all testing was conducted after the termination of the training schedule. This created a variable time interval between training and testing, ranging from one week to two months. All trainees in a particular class were tested at the same time and the schedule was arranged so that the interval was the same for each class within a pair of simulator and conventional classes. While two months is not sufficient time to establish the durability of training accomplishments, it was expected to provide some indication of how well the effects of training lasted, since forgetting of learned material typically occurs at a rapid rate shortly after training, tapering off to a slow rate thereafter.

Of the 238 individuals trained, a total of 193, or 81%, returned for testing. The remainder were unavailable due to reassignment, TDY, leave, and a variety of other reasons not connected with their performance in driver training. Comparisons of tested and untested trainees disclosed no differences of practical

or statistical significance on pretest scores. The number of simulator and conventional trainees returning was almost equal, 98 and 95, respectively.

In comparing pretest variables between groups of those who returned for testing, it was discovered that the difference between the experimental and the conventional students was statistically significant on one of the 34 variables ($p < .05$).[1] With this many comparisons, the emergence of one such difference of apparent "significance" may be expected by chance alone, and is consistent with the proposition that the two groups originally represented chance samplings of a single student population. The likelihood of there being important unmeasured differences between the two groups is small.

The single statistically significant difference that did occur was the fact that more of the conventional students had previously received some form of driver education. The practical importance of this factor is negligible as previous driver education was found to be uncorrelated with any criterion measure. This lack of relationship is not surprising in view of the many different things subsequent interviews showed the trainees had labeled "driver education."

In summary, there was no evidence of any systematic differences between those entering simulator versus conventional instruction, nor those returning for testing versus those unavailable. All trainees can be considered a chance selection from the same Fort Lewis population. Any difference in criterion scores, therefore, can be attributed to the training which they received.

The testing period was of approximately four hours' duration. Two test periods were scheduled each day, one in the morning and one in the afternoon. The first hour was usually spent trying to locate trainees who had failed to report for testing. A few of these had to be rescheduled for later test periods. Of the remaining three hours, two were allotted to the written measures and an hour to the test films, administered in that order.

RESULTS

Test performance had been expected to diminish as the period between training and testing lengthened, but no such trend was found. The fluctuation of individual class means over time showed no pattern; for this reason only the overall simulator and conventional group means are shown or discussed. Intercorrelations among pre- and post-training variables are provided in Appendix C. The results for each criterion measure are shown in Table 1.

Driving Knowledge

Items for the knowledge test came, as noted earlier, from two sources, the material covered in the simulator program and that dealt with in the common lecture periods. The results, as seen in Table 1, show that the simulator group was slightly superior on simulator items (13.2 to 12.5 items correct) while the conventional group had a slight advantage on the lecture items (11.6 to 11.0 items correct). Although the associated statistical probabilities are in the doubtful range, the results suggest that the use of simulation may facilitate, to a very slight extent, the learning of that information featured in the simulator program. Any such advantage may, however, be gained at the expense of a slight loss of information covered elsewhere in the course.

[1] A Chi-square test of significance was employed.

Table 1

Results for Each Criterion Measure

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Measure	Simulator		Conventional		p[a]
	Mean	Standard Deviation	Mean	Standard Deviation	
Knowledge Test					
Simulator	13.2	2.6	12.5	2.9	<.15
Lecture	11.0	2.6	11.6	2.7	<.15
Driving Habits					
Signals	14.7	3.9	13.0	3.1	<.01
Speed	18.4	3.0	18.8	2.9	NS
Caution	29.4	5.0	26.3	5.0	<.01
Brake	10.3	3.4	10.2	3.3	NS
Attention	9.1	2.9	8.0	2.4	<.01
Total					
Film I	17.3	3.9	15.8	3.6	<.01
Film II	64.5	8.1	60.4	6.5	<.01
I & II	81.8	11.0	76.2	8.9	<.01
Behavior Report					
Simulator	12.8	2.9	12.2	3.5	NS
Lecture	10.4	2.9	10.4	2.9	NS
Total	23.2	5.9	22.6	6.0	NS
Opinion Survey	45.9	6.6	46.1	5.0	NS

[a]Probabilities refer to the *approximate* likelihood of a between group difference of the size indicated occurring by chance alone, for independent comparisons. The figures must, however, be interpreted in light of the number of comparisons made. For the knowledge test, a covariance analysis was used, controlling for score on the knowledge pretest. Simple two-tailed *t*-tests were used for the remaining comparisons.

Driving Habits

The simulator printed readouts were scored by adding the number of correct responses. Partial credit was given when the individual changed from an incorrect to a correct response during the time his response was registered.

The simulator group exhibited markedly and significantly better performance in the use of turn signals, precautionary responses, and attention to potential emergencies. No differences of consequence occurred in maintaining proper speed, or in maintaining brake pressure when stopped.

While some portion of the simulator trainee's advantage is undoubtedly due to his greater familiarity with the simulator equipment and the scoring system, it would be difficult to attribute it entirely to this source in view of the equality of the two groups in two of the test categories. It appears that the simulator group performed better in those driving habits which were subject to the heaviest emphasis in their training.

Behavior Report

The means given for the behavior report refer to the number of items on which improvement was reported. The slight difference favoring the simulator group arises out of those 16 items which dealt with behavior included in the simulator program. However, this difference can be attributed to chance. On the remaining 14 items, including such activities as driving while fatigued and using seat belts, the groups did not differ.

In order to measure the tendency of individuals to use socially acceptable answers in reporting on their behavior, a measure of "social desirability"[1] was assembled from items taken from an existing scale.[2] While the social desirability measure was significantly related to scores on the behavioral report, the relationship was too small ($r = .17$) to be of practical significance.

Opinion Survey

The simulator and conventional groups scored almost identically on the opinion survey. There is apparently no difference between the two types of training in influencing the opinions solicited. A small but highly significant ($p < .01$) improvement over pre-training scores was found for both groups.

Inspection of the specific items does not show any trends that can be interpreted. The differences between groups were small and apparently due to chance. The simulator group's opinions on items dealt with in simulation were no more positive than were those of the conventional group.

Despite the similarity between the two group means, an overall standard deviation of 5.7 indicates the existence of a moderate diversity of opinion among individual trainees. The correlation of items with one another was fairly low, from essentially zero to .41 with a median of .20, indicating that opinions on issues of safety are rather specific to the particular issue involved. This low relationship tends to counter fears that responses were dictated by a general desire to "look good." Similar indication is provided by the fact that the correlation between the opinion survey and the social desirability measure is low (.11) and nonsignificant.

Other Indices

As in most Army courses, trainees filled out course critiques upon completion of the program. Two of the critique items were concerned with the manner of instruction, one asking explicitly for an evaluation of the instruction, the other calling for more general comment. In order to analyze critiques, evaluative remarks offered for each item were rated as "excellent," "good," or "neutral." Correlations between the two raters assigning the comments to categories were .87 and .92 for the two items. The raters had no knowledge of which type of training each trainee had received. When the groups receiving the two types of training were compared, there were no significant differences between them with respect to either the number or the nature of evaluative comments.

The instructional staff was also queried upon completion of the preliminary study, before the results were known. All were favorably disposed toward simulation prior to the study, and remained at least mildly so throughout. They were, however, somewhat surprised at their ability to hold class interest without simulators during the conventional classes. They felt further that, with more time for preparation of the course and better training aids, the conventional program could be improved considerably.

[1]The measure consisted of 50 self-descriptive words or phrases such as "often admired," "dominating," which the individual checked as true or false. The socially desirable responses were identified by having a test group respond in such a way as to "look good."

[2]W.S. Kogan, personal communication, VA Hospital, Seattle, Washington, September 1964.

DISCUSSION

The place of automobile simulators has been established in driver instruction for beginners, through provision of an economical substitute for actual automobiles in certain portions of driver education. The present study has attempted to estimate the potential usefulness of simulators in fostering safe vehicle operation.

Value of Current Simulators

The simulator was found to yield slightly better performance than conventional media in tests of the knowledges covered in the simulator programs. There was no support for the notion that the use of simulators stimulates course interest enough to facilitate learning of other aspects of safety training; if anything, the conventional trainees evidenced slightly greater learning of the subjects taught in common.

Because they are of marginal statistical significance, these differences may not be easily interpreted. It is worth noting, however, that simulation is a time-consuming means of communicating information per se. Had the same amount of time been devoted to repetition of material during conventional classes, any differences between the two groups might have disappeared. Any differences in knowledge between the two groups appear to result from the degree of emphasis in instruction rather than from the media of instruction used.

Simulation appears no more effective than conventional media in molding driver attitudes. While exposure to simulated emergencies could be expected to have a cautionary effect, a similar effect apparently can be achieved by other means.

The simulator's unique advantage appears to be its capability for influencing driving habits by permitting appropriate responses to be practiced repeatedly. In current simulator programs considerable attention is placed upon certain motor and perceptual habits, and this attention results in superior performances of simulator trainees. However, the advantage is confined to those habits receiving the heaviest emphasis, indicating that considerable practice must be provided in order to establish a particular response as a habit. It must be stressed that these results are confined to the test situation; whether or not the responses would occur in normal driving remains an open question. Further evaluation of simulators employing long-term driving behavior as a criterion does not appear to be warranted by the limited effects of the simulator studied.

Simulator Potential

The results of the study do not deny a potential value to automobile simulation. Using simulation, driving habits may be taught directly rather than through motivational influences (e.g., safety campaigns, enforcement measures), a capability unique to simulators. Similarly unique is the capability of simulators to develop certain safe driving skills, particularly those involving discrete responses to emergencies. However, if the potential of automobile simulators for driver improvement is to be realized, film programs designed for instruction of beginners will not be enough to accomplish the objective.

First, to have a significant effect upon individual driving records, the simulator will have to embrace a wider range of driving habits; gaps in existing film content must be filled. For defensive driving, research is needed to identify the

cues of potential danger so that they may serve as the focal points for perceptual habits. Similarly, means of escaping impending collisions or other emergencies can be identified and given sufficient practice to assure rapid, skilled reactions.

Second, attention needs to be shifted from learning to the retention of learning, since both habits and skills tend to deteriorate without repeated practice over time. Preparation of additional film content is needed to permit repeated exposure, and an optimum schedule for presentation should be devised.

Third, with increased emphasis upon retention, the role of simulators is likely to become, increasingly, a diagnostic one. Programs may be offered in a "test yourself" frame to capitalize upon competitive interests. Certain equipment changes may facilitate this alteration of the simulator's role. For example, further automation of the scoring system to relieve the instructor of the task of identifying and recording student errors would enable him to manage a greater number of students per unit of time and to give more attention where it is needed.

CONCLUSIONS

1. The simulator studied is superior to conventional media in fostering safe driving habits when such habits are the object of heavy emphasis in simulator programs. It is not superior in communicating driving knowledges or molding drivers' opinions with respect to safety.

2. Simulators represent a promising approach to the development of safe driving habits and skills. Realization of the simulator's full potential is likely to require substantial modification of simulator films, equipment, and schedule of presentation.

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AND
APPENDICES

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Appendix A

CRITERION MEASURES

Driving Knowledge Test

The following items comprised the multiple-choice Driving Knowledge Test. The subject was required to select one of four alternatives. The underlined portion is the correct answer. Those items which are covered by the simulator program are indicated as (S).

1. When manual ("stick") shift cars are parked, they should be left in reverse gear. (S)
2. A diamond-shaped traffic sign (◇) always means caution.
3. Accident records show that almost every collision involves a violation.
4. To keep the windshield clear in winter, use defroster and heater and keep a window open slightly.
5. To slow down on ice, "pump" the brake pedal rapidly.
6. Weekend accidents involving off-duty military personnel often involve travelling long distances in too short a time.
7. To reduce glare from approaching headlights look ahead and down toward the edge of the road.
8. A triangular shaped traffic sign (▽) always means yield. (S)
9. Fatality rates on freeways, based on miles driven, are considerably less than those on ordinary highways.
10. When passing, pull out well ahead of time. (S)
11. The following distance before starting to pass a truck should be greater than it would be for a car. (S)
12. When parking downhill beside a curb, the wheels should be left pointed away from the street. (S)
13. You are stopped at a stop sign, waiting to turn left. Wheels should be pointed straight ahead. (S)
14. In night driving, how long does it take your eyes to recover after looking into another car's headlights? Almost 10 seconds.
15. Which is a right-of-way rule in effect in most places? A vehicle already in an intersection has the right of way over another vehicle approaching from a different direction.
16. "Highway hypnosis" means sleepiness caused by monotonous driving.
17. The person who drinks and then walks in traffic is involved in more fatal accidents than the drinking driver.
18. The best cure for motor vehicle accidents is voluntary observance of traffic regulations.
19. When walking on a road with no sidewalk, you should walk on the left side of the road.
20. If the rear wheels start spinning while you are trying to start, release the gas pedal and start more slowly.
21. A rule of thumb for going down hills is use the same gear used in going up.
22. The "point system" is a system of recording driver violations for corrective action.

23. When driving through slush at near-freezing temperatures try the brakes at intervals.
24. When parking uphill beside a curb, the wheels should be left pointed toward the street. (S)
25. When driving on a curve, you should brake before going in and accelerate slightly coming out. (S)
26. What effects are always present with the use of alcohol? Impairment of reason and judgment.
27. What is the first thing to do if you have a blowout? Ease up on the accelerator.
28. A person who has just left an expressway tends to drive faster than he thinks he is. (S)
29. Which group represents the greatest traffic accident problem? Social drinkers.
30. On the basis of miles driven, how does the fatal-accident rate for night driving compare with the rate for day driving? It is 2 to 3 times higher for night driving.
31. About what proportion of fatal accidents involve drinking drivers? 1 out of 3.
32. Just before merging with traffic on an expressway, you should be travelling at their speed.
33. How long does it take to stop at 60 mph, under the best conditions? About the length of a football field.
34. By how much does 3 ounces of alcohol (about 4 mixed drinks) increase the likelihood of an accident? 1000 percent.
35. The position of the hands on the wheel should be at the 10 and 2 o'clock positions. (S)
36. If you find you have lost your foot brakes, the first thing to do is pump the foot brakes. (S)
37. When parking uphill on a street with no curb, leave the wheels pointed away from the street. (S)
38. The most important quality for a driver to have is good attitudes.
39. A driver who is angry or disturbed should allow for a cooling-off period before driving.
40. The most important reason for examining the exhaust system regularly is to discover carbon monoxide leaks.
41. You are stopped at a red light. You should have your foot on the brake. (S)
42. A driver leaving an expressway should start slowing down just after he enters the deceleration lane. (S)
43. How many deaths have been caused by motor vehicles, compared with wars? Twice as many as wars.
44. To help a person injured in an accident, what should you do if you don't know first aid? Keep him warm and try to control bleeding.
45. If you are forced onto a soft shoulder at high speed, pump the brakes.
46. You are stopped in a line of traffic headed uphill, waiting for the light to change. You should keep the car positioned by setting the parking brake.
47. The dangerous effects of alcohol on a driver begin with the first drink.
48. You are travelling on a city street with 3 lanes going in your direction. If you do not intend to leave the street for a while, you should travel in the center lane.
49. You are approaching a bus moving slowly in the opposite direction. It has flashing yellow lights. You should slow down.
50. The largest number of pedestrians killed in traffic were crossing where there was no intersection.

Opinion Survey

The subject was asked to select the alternative which corresponded most closely to his own opinion.

1. Courses in driver education
   a. Probably don't have much effect.
   b. Are a good idea but shouldn't be required.
   c. Should be required of all traffic violators.
   d. Should be required of everyone.
2. Drinking and driving:
   a. You should never drive if you have had anything at all to drink.
   b. You should try to avoid driving if you have had something to drink.
   c. A small amount of alcohol won't prevent you from driving safely.
   d. Some people can drink quite a lot and still drive safely.
3. Long non-stop trips
   a. Are perfectly safe if you are in good shape.
   b. Should be avoided when it is convenient to do so.
   c. Should be avoided if at all possible.
   d. Must always be avoided.
4. Driving at night
   a. Is never as safe as daylight driving.
   b. Is generally not as safe as daylight driving.
   c. With special precautions can be as safe as daylight driving.
   d. Is just as safe as daylight driving.
5. Other drivers:
   a. You should keep an eye peeled occasionally for the actions of other drivers.
   b. You should constantly be on the lookout for other drivers.
   c. Watching out for other drivers is one of the most important things in driving.
   d. Watching out for other drivers is the single most important thing in driving.
6. Attention:
   a. You should never take your mind off driving even for a moment.
   b. You should try to keep your mind on driving every second you are behind the wheel.
   c. It isn't always necessary to devote all your attention to driving.
   d. It isn't necessary to devote all your attention to driving when you are a skilled driver.
7. Speeding tickets:
   a. A speeding ticket isn't anything to worry about.
   b. You can't help getting a speeding ticket once in a while.
   c. Getting a speeding ticket is something to be really concerned about.
   d. A speeding ticket is a serious crime.
8. Seat belts
   a. Should be required by law.
   b. Are a good idea but shouldn't be required.
   c. May or may not be a good idea.
   d. Don't do much good and may be a hazard.

9. Icy roads
    a. Are no worse than ordinary roads once you know how to handle them.
    b. Require a little extra caution.
    c. Are extremely dangerous.
    d. Should always be avoided.
10. Night driving:
    a. You should never drive at night if you are the type that gets drowsy.
    b. At the first sign of drowsiness, you should stop driving for the night.
    c. When you begin to feel drowsy, you should stop to rest for a while.
    d. When you begin to feel drowsy, a cup of coffee will usually fix you up.
11. When other drivers don't dim their headlights, you should
    a. Keep your high beams on until they dim theirs.
    b. Flash your high beams at them intermittently until they dim theirs.
    c. Flash your high beams at them once.
    d. Dim yours and ignore them.
12. The rule of maintaining one car length for every 10 miles per hour
    a. Should be adhered to if possible under all conditions.
    b. Has to be broken once in a while, as when people cut in front.
    c. Should be followed when convenient.
    d. Doesn't apply to younger people and those who react quickly.
13. When turning at heavily crowded intersections, you should
    a. Try to nose very carefully through the flow of pedestrians.
    b. Try to move through wherever there is a gap in the flow of pedestrians.
    c. Wait until there are no pedestrians actually in the intersection.
    d. Wait until there are no more pedestrians waiting to cross.
14. Getting out on the street side of a car
    a. Is never permissible.
    b. Is all right if passengers make it inconvenient to get out on the curb side.
    c. Is all right when there are no cars coming from behind.
    d. Is all right when there is room between you and passing cars.
15. You have to pull over for an emergency vehicle such as an ambulance
    a. When it couldn't otherwise get by you.
    b. If it is going in the same direction, even if it could get by.
    c. Even if it is on the other side of the street.
    d. Even if it is on the other side of a divided highway.
16.[1] The Fort Lewis Driver Safety Education Course
    a. Gave me a whole new outlook on driving.
    b. Made me a much safer driver.
    c. Helped me drive a little more safely.
    d. Was a complete waste of time.

[1]In the pre-training administration, the future tense was used, e.g., "will probably."

Test Reels on Driving Habits

Two test reels were assembled from footage not included in the simulator program.

Test Reel 1 (Total running time—15 min.: 55 sec.)

Winding Country Road (3 min.: 50 sec.)

Expressway (1 min.: 40 sec.)

Expressway (2 min.: 26 sec.)	Response Check
Signal for turn	1. Signal right
Speed check	2. (unscored)
Signal for turn	3. Signal right
Speed prior to deceleration lane	4. Accelerator
Car that missed turnoff backing	5. Brake
	6. Brake
Stop at red light	
Waiting for light to change	7. Brake

2-Lane Rural Road (4 min.: 53 sec.)

Speed check	8. Accelerator 2 or 3
Car approaching from driveway right	9. Accelerator up
	10. Brake
4-way stop sign	11. Accelerator up
	12. Brake
	13. Brake
Continue	14. Accelerator 2 or 3
Cattle crossing road ahead	15. Accelerator up
	16. Brake
	17. Brake
Bicyclist left and tractor right	18. Brake
	19. Brake

4-Lane Rural Street (2 min.: 55 sec.)

Speed check	20. Accelerator 2 or 3
Driver leaving car on street side	21. Brake
	22. Brake
Waiting for red light to change	23. Brake
Pedestrian standing in roadway right	24. Accelerator up
	25. Brake
Pedestrian standing between parked cars	26. Accelerator up
	27. Brake
Waiting for red light to change	28. Brake

Test Reel 2 (Total running time—15 min.)

Rural Town-to-Town (6 min.: 30 sec.)

Proceed from red light	
Truck enters from side street right	1. Accelerator up
	2. Brake

	Response Check
Truck stops at railroad crossing	3. Accelerator up
	4. Brake
Truck signals and turns right	5. Accelerator up
	6. Accelerator up
Speed check	7. Accelerator 2 or 3
Crossing bridge	8. Center steer
Car approaches from secondary road right	9. Brake
	10. Brake
Approaching car cuts left across path	11. Brake
	12. Brake
Speed check	13. Accelerator 2 or 3
Approaching urban area	14. Accelerator 1 or 2
Vehicle exits from motel right	15. Accelerator up
	16. Brake
Posted speed limit	17. Accelerator 1 or 2
Light City Traffic (3 min.: 5 sec.)	
Signal left	18. Left signal
Reduce speed	19. Accelerator 1 or 2
Signal left	20. Left signal
Approaching truck blocks turn	21. Negative left steer
Truck passes (recouping a notching error)	22. Left steer
Car enters from service station right	23. Brake
	24. Brake
Speed check	25. Accelerator 2 or 3
Slow for car ahead waiting to turn left	26. Accelerator 1
Signal for lane change to the right	27. Right signal
	28. Right signal
Speed check	29. Accelerator 2 or 3
Pedestrian waiting to cross on right	30. Accelerator 1
Truck approaching from driveway right	31. Accelerator up
	32. Accelerator up
Parallel parked car pulls out suddenly	33. Brake
	34. Brake
Slow for truck ahead blocking lane	35. Accelerator up
Signal for lane change left	36. Left signal
	37. Left signal
Heavy City Traffic (5 min.: 25 sec.)	
Proceed from red light	
Hold brake at next red light	38. Brake
Vehicle merges from right lane	39. Brake
	40. Center steer
	41. Brake
Car from right cuts left across path	42. Brake
	43. Brake
Speed Check	44. Accelerator 2 or 3
Left signal	45. Left signal

	Response Check
Reduce speed	46. Accelerator 1 or 2
Left signal	47. Left signal
Pedestrian crosses between parked cars	48. Brake
	49. Brake
Parallel parked car pulls out suddenly	50. Brake
	51. Center steer
	52. Brake
Car approaches from alley right	53. Accelerator up
	54. Accelerator up
Right signal	55. Right signal
Stop for red light	
Right signal	56. Right signal
Waiting for light to change	57. Brake
Pedestrian and car cross while turning	58. Accelerator up
Waiting at next red light	59. Brake
Pedestrian crosswalk occupied	60. Accelerator up
	61. Brake
Car left backs from angle parking slot	62. Accelerator up
	63. Brake
	64. Brake
Speed check	65. Accelerator 2 or 3
Car pulls out from hotel driveway left	66. Brake
Man opens door for woman on street side	67. Accelerator up

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Each of the following items was to be checked true or false. The "safe" response is indicated in parentheses, T = True, F = False.

1. My use of hand signals hasn't increased any. (F)
2. I am much less likely to drink and then drive. (T)
3. If the driver ahead is travelling the speed limit, I am less likely to pass him. (T)
4. I don't think the course has helped me much in handling blowouts. (F)
5. I probably ignore just as many caution signs. (F)
6. I signal before more turns than I used to. (T)
7. I'm much more aware of errors other drivers make. (T)
8. I probably go through as many yellow lights as I used to. (F)
9. I am much more conscious of my own driving than I used to be. (T)
10. If a driver won't dim his lights for me, I'm just as apt to use my high beams on him as I used to. (F)
11. I don't look at my speedometer any more often than before. (F)
12. I don't think I check my rear view mirror any more often. (F)
13. I am much more on the lookout for parked cars that might pull out. (T)
14. I guess I'm no better at remembering to dim my lights when following another car at night. (F)
15. If I see a sign saying, "Curve—25 mph," I am more likely to slow to 25 and not just 35 or 30. (T)
16. I drive more slowly at night than I used to. (T)
17. If I lost my brakes, I think I could handle the situation better now. (T)
18. If my passenger doens't fasten his seat belt, I usually don't say anything. (F)
19. I go over the speed limit on clear, straight roads about as often as before. (F)
20. I don't think I stop any more frequently on long trips. (F)
21. To be honest about it, I'm just as guilty of tailgating as I used to be. (F)
22. I'm much more watchful of pedestrians. (T)
23. I don't signal for a lane change on expressways any more often. (F)
24. When I am a passenger in a car going too fast, I am more apt to tell the driver to slow down. (T)
25. I'm just as likely to speed up to get through a green light. (F)
26. I signal more stops with a hand signal. (T)
27. I more often turn my head to look back after completing a pass, before returning to the lane. (T)
28. My use of seat belts has not increased (or wouldn't if I had them). (F)
29. I am much more aware of other drivers than I used to be. (T)
30. If I found myself getting sleepy on an expressway, I would be more likely to stop right away, rather than wait until the exit. (T)

Appendix B

TRAINING PROGRAMS[1]

Common Subjects: 7 hrs.
(Both Groups)

Introduction and Orientation*
Psychology of the Driver and Stopping Distance
Human Physical Conditions
Driving Under Adverse Conditions
Traffic Laws
Observance and Enforcement
Taking Care of Your Car
The Pedestrian and the Driver*

Simulator Subjects: 8 ½ hrs.
(Simulator Group Only)

Introduction
Blending in Traffic
Perfect Passing
Safe Highway Driving
Driving Emergencies
Traffic Strategy
Special Driving Techniques
Expressway Excellence
Road Check*

Conventional Subjects: 8 ½ hrs.
(Conventional Group Only)

Driving in Traffic
City Driving
Passing
Highways and Expressways
Defensive Driving
Other Highway Users
Emergencies
Driving Situations
Review*

Non-Academic Subjects: 4 ½ hrs.
(Both Groups)

Processing, Examinations, Graduation, Clean-up

TOTAL COURSE: 20 hrs.

[1]Each subject was taught for one hour except for those marked with an asterisk (*), which were half-hour subjects.

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Appendix C

Correlation Matrix of Post-Training and Selected Pre-Training Variables[a]

Variable	Pre-Training Measures			Driving Habits						Behavior Report	Opinion Survey	Knowledge Test
	Knowledge Test	Opinion Survey	Age	Turn Signals	Brake	Caution	Speed	Attention	Total			Simulator Items
Pre-Training Measures												
Opinion Survey	-.10											
Age	.06	.10										
Driving Habits												
Turn Signals	.04	.09	-.13									
Brake	.07	-.10	-.06	.16*								
Caution	.15*	.11	-.09	.30*	.02							
Speed	-.02	.09	-.01	-.01	-.10	.13						
Attention	.15*	-.04	-.24*	.25*	.18*	.42*	-.05					
Total	.15*	.07	-.18*	.62*	.42*	.77*	.30*	.61*				
Behavior Report	-.16*	.38*	.03	-.05	.06	-.02	.15*	-.09	.01			
Opinion Survey	-.04	.64*	.14*	-.08	-.03	.11	.02	-.10	.00	.36*		
Knowledge Test												
Simulator Items	.42*	.02	.08	.11	.11	.23*	-.02	.14*	.22*	-.11	.10	
Lecture Items	.41*	-.14	.05	-.02	-.01	-.03	.05	.07	.01	-.15*	-.08	.43*

[a] *indicates statistical significance at the .05 level.

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13. ABSTRACT

The purpose of this research was to determine the effectiveness of automobile simulators in fostering the safe operation of automobiles. A 20-hour driver improvement course was administered to 238 licensed drivers at Fort Lewis, Washington. Approximately half of the trainees received a program taught entirely by conventional methods, while the other half received a program of similar content but including eight hours of simulator instruction. Results of specially constructed tests indicated that simulators were superior to conventional media for developing good driving habits but were no more effective in teaching driving knowledges or influencing driver attitudes. It was concluded that, while simulation represents a potentially valuable means of improving driver habits and skills, substantial modification of current simulator equipment and film is needed to attain this potential.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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